Short summary of George Ellis's five top down causes in complex systems

Martin Euser, May 2019

George Ellis has formulated five top-down causes in complex systems (modular hierarchical systems). His personal webpage is here.
Lots of discussions on his article can be found here.
It pays well to study his long article carefully.
He describes the following five top-down causes (TDCs) in complex systems (all quotes are from his article):

TDC-5: Intelligent top-down causation

TDC-4: Top-down causation via adaptive information control

TDC-3: Top-down causation via adaptive selection

TDC-2: Top-down causation via non-adaptive information control (simple feedback control system)

TDC-1: Mechanical top-down causation

A short overview of these causes:

TDC-1: Mechanical top-down causation as in fluid convection, phase transitions in physical systems, diesel engines, arrow of time, nucleosynthesis in the early universe.

Note that this is "the kind of causation envisaged in the physicalist reductionist world view"
It has to do with system structure and boundary conditions. I will spend not much time on this one. I also have my doubts whether the arrow of time is a completely mechanical cause.

TDC-2. Non-adaptive information control. This has to do with higher level entities that influence lower level entities, "so as to attain specific fixed goals through the existence of feedback control loops, whereby information on the difference between the system actual state and desired state is used to lessen this discrepancy "

So, we have information flows and an evaluation of that information relative to the chosen goals. The goals "are embodied in the system structure and so do not change with time"
This underlies all homeostatic systems. Also see the figures and tables at the end of his article. Examples: steam engine governor, thermostat, homeostatic systems, energy homeostatis, ribonuclease action, neuronal axons. See Ellis's text for more info.

TDC-3. Adaptive selection. "Adaptive processes take place when many entities interact, for example the cells in a body or the individuals in a population, and variation takes place in the properties of these entities, followed by selection of preferred entities that are better suited to their environment or context" So, this is very much a context dependent process

where a selection agent plays a role. Examples: Darwinian evolution; developmental biology; the adaptive immune system.

TDC4. Top-down causation via adaptive information control "Adaptive information control takes place when there is adaptive selection of goals in a feedback control system, thus combining both feedback control and adaptive selection. The goals of the feedback control system are irreducible higher level variables determining the outcome, but are not fixed as in the case of non-adaptive feedback control; they can be adaptively changed in response to experience and information received.
The overall process is guided by fitness criteria for selection of goals. This allows great flexibility of response to different environments, indeed in conjunction with memory it enables learning and anticipation and underlies effective purposeful action, as it enables the organism to adapt its behaviour in response to the environment in the light of past experience, and hence to build up complex levels of behaviour."

Examples: associative learning in animals, such as Pavlovian conditioning. "The training is causally effective by top-down action from the brain to cells in muscles. The fitness criterion is avoidance of negative stimuli; change of the associated goals (through a change in the environment) results in change of behaviour. More generally, the mind works by adaptive prediction of what is likely to happen, updated on an ongoing basis
This underlies most of our mental ability. "

TDC5. Intelligent top-down causation (the effect of the human mind on the physical world) "Intelligent top-down causation is the special case of feedback control with adaptive choice of goals where the selection of goals involves the use of symbolic representation to investigate the outcome of goal choices. Here a symbolic system is set of structured patterns realized in time or space, that is arbitrarily chosen by an individual or group to represent objects, states, and relationships
It will generally involve hierarchical structuring and recursion, as is required if it is to be useful in understanding complex situations, and has the potential to enable quantitative as well as qualitative investigation of outcomes."
"A key feature is the causal power of images and formal and informal causal models of the natural and social worlds, ranging from mental images of what might happen to elaborate quantitative models of physical entities and societies These abstract entities (which are shared among many minds) play a large part in formulating our understandings and consequent actions, and hence are causally effective in the real world as they help us attain our goals. This is based in subjective personal experience."
Examples: The value of money; roles, expectations and values; language; abstract symbolism (e.g. Mathematics). The examples are elaborated in Ellis's text.

The "causal power of images and formal and informal causal models of the natural and social world" are mentioned as well. Meaning and ethics are dealt with too. Very insightful ideas! TDC-3,4,5 are involved in complex adaptive systems. Bottom-up and top-down causation work together via feedback loops to enable the existence of such systems. Then follows a section on Aristotles's four forms of causation, which are reinterpreted by Ellis.

The key point of the whole article for me is that Ellis presents good arguments *why a reduction from top-down causes to purely material causes*

is not possible. I wholeheartedly agree with that observation.
Other scientists, such as Stafford Beer, have written volumes on the need for **meta**-levels beyond the level of molecular interactions, in models of the enterprise and the human organism. See Beer's companion volumes "Brain of the Firm" and "Heart of the Enterprise".

Beer's five levels, necessary for viable systems have strong relations with Ellis's top-down causes, a subject that I might discuss in another essay
A related subject is the genesis of these meta-levels, a riddle that no scientist understands, but on which the ancient wisdom-tradition has some profound ideas to share. Lastly, quantum physics has made a crack in the old materialistic mode of thinking of the "billiard ball" universe. We now know about the dualistic nature of matter: the wave-particle properties of matter. Now, in the information age, we have arrived at the triangle *matter-energy-information*. Add consciousness and meaning to the mix, and we will finally get somewhere!